

## **Mobilisation and natural attenuation of heavy metals in the mine tailing of La Calamine (East-Belgium)**

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From the Middle Ages until the beginning of the 20<sup>th</sup> century, extensive Zn-Pb mining and smelting was carried out in Plombières and La Calamine (eastern Belgium). Besides the important amount of waste that is stored in huge mine tailings, overbank sediments along the Geul river, which flows through the mine tailings, are also severely contaminated with Zn, Pb and Cd. The distribution pattern, the potential mobilisation and (natural) attenuation of Pb, Zn and Cd in the mine tailing of La Calamine and in overbank sediments downstream of the Pb-Zn mining district of La Calamine was investigated.

The main minerals in the La Calamine dump were ZnS (Wurtzite), ZnCO<sub>3</sub> (smithsonite), anglesite (PbSO<sub>4</sub>), pyrite (FeS<sub>2</sub>) and marcasite (FeS<sub>2</sub>). Whereas lower pH values (between 3 and 4.9) were encountered in the deeper part of the tailing (between 2.6 and 4 m depth), a lower mobility of Zn, Pb and Cd was found compared to the upper part of the tailing, where pH was in the range 5-7. pH<sub>stat</sub> leaching tests and chemical extractions confirmed that Pb-Zn minerals control the solubility of Zn, Pb and Cd in the mine tailings. Contrary, in the overbank sediments, the release of Zn, Cd and Pb is mainly determined by pH and organic matter content.

The oxidation of sulphide minerals within the mine tailing releases H<sup>+</sup>, SO<sub>4</sub><sup>2-</sup>, Fe<sup>2+</sup>, and trace metals into the porewater. Subsequent pH-buffering in CaCO<sub>3</sub>-rich layers results in the precipitation of secondary minerals such as ZnCO<sub>3</sub>, FeCO<sub>3</sub> and CaSO<sub>4</sub>·2H<sub>2</sub>O. This precipitation processes result in the formation of cemented layers, which show an enrichment in Cd and Zn. Whereas these CaCO<sub>3</sub>-rich layers provide some natural attenuation of trace metals, elevated Zn-, Pb- and Cd concentrations are found in the porewater in the surface layers of the tailing (0-2.6 m depth). Therefore, the feasibility of the addition phosphates as an immobilisation technique for Pb, Zn and Cd was investigated.

For a sustainable development of the mining area of La Calamine, run-off from the mine tailings must also be limited. The addition of phosphates can effectively reduce heavy metal solubility and contribute to a reduction of the release of Pb, Zn and Cd into the environment.

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